FILM TRAP AND GATE ASSEMBLY FOR A MOTION PICTURE PROJECTOR

BACKGROUND OF THE INVENTION

[0001] In motion picture projectors, a succession of transparent or semi-transparent still images or frames are sequentially advanced before a suitable light source, thereby projecting an image onto a projection surface. The film is moved or advanced until a frame is in alignment with the projection aperture and then held stationary for a discrete period of time during which light is passed during two discrete time periods through the aperture, film frame, and then a focusing lens, resulting in an image being projected onto a screen. This is followed by movement of the film until the next frame is in alignment with the projection aperture. The rapid sequential advancement of the individual still frames, typically on the order of 24 frames per second, produces the illusion of motion. Typically, the film disposes at least one soundtrack synchronized with the picture projection. In this regard, recent advances in analog and digital sound recording technology have been rapidly incorporated in to modern films and film projector sound systems, more commonly referred to as "sound heads".

[0002] To effectuate sequential film advancement, motion picture projectors utilize toothed drive sprockets connected to a motor driven "star wheel" to sequentially pull a length of film before the light source. Such motion picture projectors further include tensioning shoes for maintaining the filmstrip in contact with the drive sprockets. The film disposes two drive tracks which are engaged by the toothed sprockets, thereby enabling frame advancement. Motion picture filmstrips generally include at least one soundtrack positioned near the edge of the film or within at least one film drive track.

[0003] Commonly, motion picture projectors utilize a film trap and gate assembly to precisely align and position a filmstrip within an illumination plane. The film trap and gate assembly includes a pair of runners which provide controlled movement of the filmstrip past an illumination aperture. The edges of the filmstrip contact the runners, pressure bands, and tensioning shoes during operation. Consequently, over a period of time the edges of

the filmstrip may become scratched or damaged due to the film remaining in constant contact with the runners, pressure bands, and tensioning shoes. Additionally, foreign materials such as dust, residues, and other impurities located on the runners, pressure bands, or tensioning shoes may be deposited on the film. The damage to the edges of the filmstrip or the foreign material deposited on the film may prevent the soundtracks from being clearly reproduced by the sound head.

[0004] Additionally, motion picture projectors are designed primarily for forward film advancement, in that the drive sprockets pull the filmstrip past an illumination aperture. On occasion, a film trap will include a sharpen device called a stripper plate located near the drive sprocket, to strip film splices when the film is moved through the projector in reverse. Pushing a flexible portion of film material past the sharpened stripper plate and past the runners, pressure bands, and tensioning shoes is often impossible. Moreover, severe damage to a filmstrip could occur should the filmstrip contact the stripper plate. As such, reversing the direction of the film, particularly while viewing, often results in damage to the film.

[0005] Thus, there is a need for a film trap and gate assembly for a motion picture projectors which reduces the amount of surface wear on the edges of the filmstrip, thereby increasing the lifetime of each film print. There is a further need for a film trap and gate assembly which enables the operator to reverse the direction of film travel without damaging the film.

BRIEF SUMMARY OF THE INVENTION

[0006] The present invention solves the need for a film trap and gate assembly which reduces the damage to a filmstrip disposed therein, thereby extending the usable lifetime of the motion picture. The film trap and gate assembly disclosed herein has eliminated the need for maintaining constant contact between the film and the spring-loaded runners, pressure bands, and steel tensioning shoes thereby reducing or eliminating may damage to the filmstrip. Additionally, the present invention permits an operator to reverse the direction

of film movement through the projector, while viewing or at higher speed, without damaging the film. The present invention may be utilized a an number of film projector systems with little or no modification required.

[0007] The film trap and gate assembly of the present invention comprises a film movement channel, which defines a discreet area which the film strip may traverse. The film movement channel, which is formed by the film gate engaging the film trap, forms and orifice larger than the thickness of the film disposed therein. Similarly, the width of the film movement channel is greater than the width of the film positioned therein. Unlike prior art systems, which utilized spring-loaded pressure bands located on the film trap which remain in constant contact with the film and forcibly bias the film against the film gate, the film movement channel of the present invention permits a degree of film movement or float within the channel. As a result, damage to the film has been reduced or eliminated while the usable lifetime of the filmstrip has been increased.

[0008] In an additional embodiment, the present invention discloses a film trap comprising a trap body having image aperture formed therein, and having a first and second trap rail assembly positioned thereon. The first trap rail assembly comprises a first trap rail in communication with a first trap guide. Similarly, the second trap rail assembly comprises a second trap rail in communication with a second trap guide. The film is positioned on the first and second trap rails. The amount of lateral displacement the film is limited by the first and second trap guides. Those skilled in the art will appreciate the present invention has eliminated the need for constant pressure applied by the spring-loaded pressure bands the film, thereby decreasing or eliminating damage to the film during operation.

[0009] Additionally, the present invention discloses a film tensioning device which is attachable to a film gate. The film tensioning device comprises a deformable body having at least tensioning roller attached thereto, and a tensioning device in communication with tensioning rollers. The deformable body may further comprise a roller cradle which positions the tensioning rollers on the deformable body. Those skilled in the art will

appreciate the tensioning rollers of the present invention may be comprised of non-abrasive materials, including, without limitation, elastomers, urethanes, and rubbers. In another embodiment, the tensioning device may be actuated to adjust the tensioning force applied by the tensioning rollers.

[0010] In yet another embodiment of the present invention a film trap and gate system is disclosed herein. The film trap and gate system comprises a film trap capable of engaging a film gate. The film trap comprises a trap body having an image aperture formed thereon, and a first and second rail assembly attached thereto. The film trap further disposes a stripper plate comprising an angled stripper blade in communication with an attachment flange. The stripper plate is attached to the attachment flange at an at least one degree angle, thereby enabling the movement of the film to be reversed. The film gate comprises a gate body having a projection aperture formed therein, and a first and second rail assembly attached thereto. A film tensioning device is attached to the gate body. The tensioning device comprises a deformable body having an attachment orifice formed therein, an a roller cradle attached thereto. The attachment orifice preferably forms an attachment slot thereby enabling the user to adjust the length of the film tensioning device with respect to the gate body. At least tensioning rollers are in communication with the roller cradle. A tensioning device is in communication with the roller cradle such that the tensioning force applied by the tensioning device may be adjusted by the user.

[0011] In an alternate embodiment, the present invention discloses a film gate stripper plate for use in motion picture projectors. The stripper plate comprises a stripper blade attached to an attachment flange. The stripper plate is angled, preferably towards the gate body, at least one degree. Those skilled in the art will appreciate the present invention permits the movement of the film to be reversed without the film contacting the stripper blade, thereby reducing the likelihood of damaging the film.

[0012] In another embodiment, the present invention discloses a film trap and gate calibration device comprising a first member and a second member. The first member has a thickness greater than the thickness and width larger than motion picture film. The

second member has a thickness and width smaller than the thickness of motion picture film. The operator may then position the trap and gate rails to be calibrated to be slightly larger or smaller than the motion picture film disposed thereon.

[0013] The present invention discloses a method of advancing motion picture film through a motion picture projector. The advancement method comprises locating film within a film projector, using the a film trap and gate assembly to form a film movement channel within the projector, positioning the film within the film movement channel, attaching the film to a film drive system, and moving the film through the film advancing channel. Those skilled in the art will appreciate the present method results in the film intermittently contacting the film trap, film gate, or both, rather than utilizing constant pressure commonly used in prior art system.

[0014] Other objects and further features of the present invention will become apparent from the following detailed description when read in conjunction with the attached drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] Fig. 1 is a schematic view of a film projector showing motion picture film threaded through the projector;

[0016] Fig. 2 is an enlarged side view of motion picture film having multiple soundtracks disposed thereon;

[0017] Fig. 3 is a perspective view of the film trap and gate assembly of the present invention having motion picture film disposed therein;

[0018] Fig. 4 is a perspective view of the film trap of the present invention;

[0019] Fig. 5 is a top view of the film trap of the present invention;

[0020] Fig. 6 is an exploded view of the film trap of the present invention;

[0021] Fig. 7a is a perspective view of an embodiment of the first trap rail assembly of the present invention;

[0022] Fig. 7b is a perspective view of alternate embodiment of the first trap rail assembly of the present invention;

[0023] Fig. 8a is a top view of the stripper plate used on the film trap of the present invention;

[0024] Fig. 8b is a side view of the stripper plate used on the film trap of the present invention showing the angled stripper blade;

[0025] Fig. 8c is a perspective view of the stripper plate used on the film trap of the present invention;

[0026] Fig. 9 is a top view of the film trap of the present invention having motion picture film disposed thereon;

[0027] Fig. 10 is a perspective view of the film gate of the present invention;

[0028] Fig. 11 is a top view of the film gate of the present invention;

[0029] Fig. 12 is an exploded view of the film gate of the present invention;

[0030] Fig. 13a is a perspective view of the film tensioning assembly of the present invention;

[0031] Fig. 13b is an exploded view of the film tensioning assembly of the present invention;

[0032] Fig. 13c is a bottom view of the film tensioning assembly of the present invention;

[0033] Fig. 14a is a side view of the film gate of the present invention having a depth set device disposed thereon;

[0034] Fig. 14b is a bottom view of film trap and gate assembly of the present invention preparing to engage film;

[0035] Fig. 14c is a bottom view of film trap and gate assembly of the present invention preparing to engaging film;

[0036] Fig. 15a is a perspective view of an embodiment of the second gate rail assembly of the present invention;

[0037] Fig. 15b is a perspective view of alternate embodiment of the second gate rail assembly of the present invention;

[0038] Fig. 16a is a perspective view of the calibration device used to calibrate the film trap and gate assembly of the present invention;

[0039] Fig. 16b is a side view of the calibration device being used to calibrate the film trap of the present invention; and

[0040] Fig. 16c is a side view of the calibration device being used to calibrate the film gate of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0041] Disclosed herein is a detailed description of various illustrated embodiments of the present invention. This description is not to be taken in a limiting sense, but is made merely for the purpose of illustrating the general principles of the invention. The overall organization of the present detailed description is for the purpose of convenience only and is not intended to limit the present invention.

[0042] Those skilled in the art will appreciate the present invention incorporating a continuous trap rail assembly and continuous gate rail assembly has eliminated the need for spring-loaded runners and pressure bands which remain in constant contact with film disposed thereon. In addition, the present invention incorporates non-abrasive tensioning

rollers rather than steel tensioning shoes, which are commonly used on prior art devices. As such, damage to the film 14 caused by the constant contact between the film trap and gate assembly 24 is reduced or eliminated resulting in an increase in film print lifetime. Additionally, the present invention further comprises an angled stripper plate, which enables a user to operate a projector in reverse, either while viewing or at higher speed (in excess of 24 frames per second).

[0043] A conventional motion picture projector for use with the present invention is shown in Figure 1. The projector 10 has a compartment 12 which receives motion picture film 14 through an opening 16. The film 14 engages a feed sprocket 18 and advances between the feed sprocket 18 and the feed roller 20. The film then engages a roller 22 and is positions the film for entering the film trap and gate assembly 24. The film trap and gate assembly 24 is comprised of a film trap 26 and a gate 28 which position the film 14 between an illumination source 30 and a projection assembly 32. The film emerges from the film trap and gate assembly 24 and engages a receiving sprocket 34. The film continues between a second feed sprocket 36 and a second roller 38, and exits the projector 10.

[0044] With reference to Figure 2, motion picture film 14 generally comprises an image area 40 positioned between a first drive track 42a and a second drive track 42b. At least one soundtrack is positioned proximate the drive tracks 42a and 42b. The film 14 shown in Figure 2 comprises four soundtracks, enabling use of the film 14 with various projection systems or sound heads. As shown, the film comprises a SDDS digital soundtrack 44a and 44b; a SRD digital soundtrack 46; an analog soundtrack 46; and a DTS digital soundtrack.

[0045] Referencing Figure 3, the film trap and gate assembly 24 is shown engaging a portion of motion picture film 14. The film trap and gate assembly 24 comprises a film trap 26 and a film gate 28. During operation, the film 14 enters the first end 52 of the film trap and gate assembly 24 and an image is projected through the projection aperture 54. The film 14 and exits the through the second end 56 of film trap and gate assembly 24. Those skilled in the art will appreciate the present invention may be manufactured from a plurality

of materials including, but not limited to, cast iron, steel, aluminum, reinforced plastic, urethane, rubber or any other useful material. Alternatively, the present invention may be manufactured from a plurality of materials. For example, the film trap 26 may utilize a relatively rigid material such as steel in one aspect, and a relatively flexible material such a urethane in another aspect.

[0046] With reference to Figures 4 and 5, the film trap 26 of the present invention comprises a trap body 58 having two apertures 60 and 62, respectively, formed therein, and having two trap rail assemblies 64a and 64b attached thereto. The first trap rail assembly 64a comprises a first trap rail 66a and a first trap guide 68a, and further disposes a first movable guide roller 70a. Similarly, the second rail assembly 64b comprises a second trap rail 66b and a second trap guide 68b, and further disposes a second movable guide roller 70b. A stripper plate 72 is attached to the trap body 58 and is positioned between the first and second trap rail assemblies 64a and 64b. As shown in Figure 5, the trap body 58 further comprises a trap attachment pin 74, which attaches the film trap 26 to the projector 10 (not shown).

[0047] Figure 6 shows an exploded view of the film trap 24 of the present invention. As shown, the first guide roller 70a and second guide roller 70b are positioned on a guide roller shaft 76 which is positioned within the first aperture 60 of the film trap 26. The plate spring 78 is attached to the film trap 26 such that the plate spring 78 is positioned within the second aperture 62. A plate 80 having an aperture 82 and having screw receivers 84a and 84b formed therein attaches to the trap body 58 with screws 86a and 86b, and is positioned over the first aperture 60 and partially occludes the second aperture 60. As shown in Figure 6, a first guide roller receiver 88a is formed in the first trap rail 66a, and a first guide roller recess 90a is formed in the first trap guide 68a. When assembled, the first rail assembly 64a, comprised of the first trap rail 66a and first trap guide 68a, is adapted to receive the first movable guide roller 70a through the first guide roller receiver 88a and recess 90a. Similarly, a second guide roller receiver 88b is formed in the second trap rail 66b, and a second guide roller recess 90b is formed in the second trap guide 68b. When assembled, the second rail assembly 64b, comprised of the second trap rail 66b and

second trap guide 68b, is adapted to receive the second movable guide roller 70b through the second guide roller receiver 88b and recess 90b. The second aperture 62 is further occluded by the attachment flange 92 of the stripper plate 72. The stripper plate comprises a stripping blade 94 integral to the attachment flange 92, and an attachment orifice 96 formed in the attachment flange 92. The stripper plate 72 is attached to the trap body 58 with a flange screw 98.

[0048] With reference to Figures 7a and 7b, the present invention discloses several embodiments of rail assemblies which may be used with the film trap 26. Figure 7a shows a first rail assembly 64a comprised of a first film rail 66a and a separate first film guide 68a. In an alternate embodiment, Figure 7b shows a first rail assembly 64a' having a first film rail 66a' integral to the first film guide 68a'. Those skilled in the art will appreciate the continuous rail designs of the present invention eliminates the need for the spring-loaded runners found in present designs, thereby reducing wear and damage to the film.

[0049] Figures 8a-8c show various views of the stripper plate of the present invention. The stripper plate 72 comprises an attachment flange 92 and a stripper blade 94 which is integral to the attachment flange 92. As shown in Figure 8b, the stripper blade 94 is attached to the attachment flange 96 at an angle. The angled stripper blade 94 of the present invention reduces the likelihood the film 14 will contact the blade portion 94 of the stripper 52, thereby enabling the user to operate the projector 10 in reverse.

[0050] Referencing Figure 9, a film trap 26 is shown having a portion of film 14 disposed thereon. As shown, the film drive tracks 42a and 42b are positioned on the trap rails 66a and 66b (not shown) between the trap guides 68a and 68b such that the film image area 40 is positioned over the first aperture 60 formed in the trap body 58. The trap guides 68a and 68b restrict the amount of lateral displacement achievable by the film 14 during operation, thereby stabilizing the image projected on a screen (not shown).

[0051] Figures 10 and 11 show the film gate 28 of the present invention. The film gate 28 comprises gate body 100 having a gate aperture 102 formed therein, and having two gate rail assemblies 104a and 104b attached thereto. The first gate assembly 104a

comprises a first gate rail 106a attached to a first gate guide 108a. Similarly, the second gate assembly 104b comprises a second gate rail 106b attached to a second gate guide 108b. The film gate 28 further disposes a film tensioning assembly 110 comprising a deformable body 112 having an attachment slot 114 formed therein. An attachment screw 116, positioned within the attachment slot 114, is used to attach the tensioning assembly 110 to the gate body 100. The deformable body 112 further comprises first tensioning rollers 118a and 118b, and second tensioning rollers 120a and 120b. As shown in Figure 11, the film gate 28 further comprises a depth set orifice 142, which will be discussed in detail below.

[0052] Referencing Figure 12, an exploded view of the film gate 28 of the present invention shown. As shown, the first rail springs 124a and 124b are positioned with the first rail spring receivers 126a and 126b. Similarly, the second rail springs 128a and 128b are positioned within the second rail spring receivers 130a and 130b. The first rail assembly 104a, which comprises a first gate rail 106a and a first gate guide 108a, is positioned on the gate body 100 covering the first rail spring 124a and second rail spring 128a. Thereafter, the first rail assembly 104a is attached to the gate body 28 with the first and second assembly screws 132a and 136a, respectively, positioned within first and second assembly orifices 134a and 138a, respectively, formed in the first gate rail 108a. Similarly, the second rail assembly 104a, which comprises a second gate rail 106b and a second gate guide 108b, is positioned on the gate body 100 covering the first rail spring 124b and second rail spring 128b. Thereafter, the second rail assembly 104b is attached to the gate body 28 with the first and second assembly screws 132b and 136b, respectively, positioned within first and second assembly orifices 134b and 138b, respectively, formed in the second gate rail 108b. A depth set device 140 is positioned within a depth set orifice 142 formed in the gate body 100. The depth set device 140 permits an operator to precisely control the clearance between the trap 26 (not shown) and gate 28 when assembled. A depth set pin 144 may be used to set the depth. The gate body 100 further comprises a tensioning assembly receiver 146 having a mounting receiver 148 disposed therein. The deformable body 112 attaches to the gate body with screw 116 which is positioned within the attachment slot 114. Those skilled in the art will appreciate the deformable body 112

enables the operator to precisely position the film tensioning member 110 in relation to the stripping plate 72, thereby limiting the contact between the film 14 and the stripping plate 72 and tensioning rollers 118a-b, and 120a-b. The deformable body 112 may be manufactured from a plurality of materials including, without limitation, aluminum, steel, or other material. In an alternate embodiment, the deformable body 112 may be manufactured from a rigid material. The components of the film tensioning assembly 110 will be discussed in detail below.

[0053] Figures 13a-13c show the film tensioning assembly 110 of the present invention. The film tensioning assembly 110 comprises a deformable body 112 having an attachment slot 114 formed therein, and having a tensioning screw receiver 152 disposed thereon. A roller cradle 156, positioned over the tensioning screw receiver 152 and receiving a tensioning device 154 within a tensioning device receiver 158, is attached to the deformable body 112 with a tensioning screw 150. In use, the tensioning device 154 exerts an adjustable biasing force to the roller cradle 156, thereby permitting the user to adjust the amount of force applied to the film 14 by the tensioning rollers 118a-b and 120a-b. By actuating the tensioning screw 150, the user increases the force applied by the tensioning device 154 to the roller cradle 156, resulting in the tensioning rollers 118a-b and 120a-b applying more force. The first tensioning rollers 118a and 118b, respectively, receive the first roller bearings 160a and 160b, respectively, and are attached to the roller cradle 156 with first roller screws 162a and 162b, respectively. Similarly, the second tensioning rollers 120a and 120b, respectively, receive the second roller bearings 164a and 164b, respectively, and are attached to the roller cradle 156 with first roller screws 166a and 166b, respectively. Figure 13c shows the film tensioning assembly 110 of the present invention attached to the film gate 28. In contrast to prior art systems, which utilize a steel tensioning shoes which contact and damage film 14, the film tensioning member 110 of the present invention incorporates non-abrasive materials. Those skilled in the art will appreciate the first tensioning rollers 118a and 118b, and second tensioning rollers 120a and 120b, may be manufactured from a plurality of materials, including, without limitation, elastomer, urethane, rubber, silicon, or other non-abrasive material. Alternatively, the film tensioning device may be incorporate friction reducing materials, such as Teflon.

[0054] With reference to Figures 14a-14, the gate 28 comprises a depth set device 140 positioned within a depth set orifice 142. The depth set device permits the operator to ensure sufficient film clearance between the film trap 26 (not shown) and the film gate 28is maintained, thereby forming a film movement channel. The operator advances the depth set device 140 such that when the film gate 28 is positioned on the film trap 26 the depth set device 140 contacts the trap body 58 wherein sufficient film clearance remains between the trap rails 66a and 66b, and the gate rails 106a and 106b. Figure 14b shows the film 14 located on the first and second trap rails 66a and 66b of the film trap 26. The film gate 28 is positioned thereabove. Figure 14c shows the film gate 28 engaging the film trap 26. Figure 14c shows the film 14, disposed within the film movement channel 168 formed by the trap rail assembly 64 and the gate rail assembly, non-biased and free to traverse the film movement channel 168.

[0055] Figures 15a and 15b show various embodiments of the rail assembly 104b of the present invention. As shown in Figure 15a, the present invention discloses a rail assembly 104b comprising a second gate rail 106b attached to a separate second rail guide 108b. In an alternate embodiment, Figure 15b shows a rail assembly 104b' comprising a second rail portion 106b' integral to a second gate guide 108b'. Similarly, the first rail assembly 104a may comprise either a separate second rail/guide assembly or an integral rail/guide assembly. The continuous gate rail assembly of the present invention cooperatively engages the continuous trap rail assembly thereby defining a discrete film pathway therebetween.

[0056] The present invention further discloses a calibration device for use with the present film trap and gate assembly 24. As shown in Figure 16a-c, the calibration device 170 comprises a trap plate portion 172 and a gate plate portion 174 attached thereto. The trap plate portion 172 is manufactured with a width slightly, e.g. .005 inch, larger to the width of film 14. To calibrate the trap 26, the user positions the calibration device 170 on the film trap 26 such that the trap plate portion 172 is located between the trap rail assemblies 64a and 64b and in communication with the plate 80. The trap rail attachment screws are then tightened. Similarly, the calibration device 170 may be used to calibrate

the gate rail assembly 104a and 104b. The gate plate portion 174 is placed on the gate 28 such that gate plate portion 174 is positioned between and in communication with the gate rail assemblies 104a and 104b. The rail attachment screws 132a-b and 136a-b are then tightened. The gate plate portion 174 is manufactured with a width slightly, e.g. .005 inch, smaller than the width of the film 14. Those skilled in the art will appreciate the present calibration device 170 permits the user to easily calibrate the film trap and gate assembly 24 without the plurality of sizing shims commonly required with present trap-gate systems.

[0057] The present invention further discloses a method of using the film trap and gate assembly 24. As shown in Figure 1, the trap 26 and gate 28 are positioned within a film projector 10 such that the trap first aperture 60 and gate aperture 102 are positioned between the light source 30 and projection system 32. Those skilled in the art will appreciate the present invention may replace existing film trap and gate assemblies for a plurality of film projection systems with little or no modification required. As shown in Figure 3, with the film trap 26 and gate 28 are positioned within the film projector 10, the film 14 is positioned on the first and second trap rails 66a and 66b. The film 14 is then made to engage the drive system sprockets 18, 34, and 36, respectively. The film gate 28 is made to engage the film trap 26, such that the first and second gate rails 106a and 106b are positioned proximate the film 14 disposed on the trap first and second rails 66a and 66b. The depth set device 140, positioned on the film gate 28, may then be actuated to ensure sufficient clearance between to the trap rails 66a and 66b, and gate rails 106a and 106b is present to permit free longitudinal movement of the film 14 positioned therebetween. The trap guides 68a and 68b, and gate guides 108a and 108b, assist in positioning and seating the trap 26 and gate 28. Thereafter, the film projector drive system is activated and the film is advanced.

[0058] Those skilled in the art will appreciate the present invention incorporating a continuous trap rail assembly 64a and 64b, and continuous gate rail assembly 104a and 104b has eliminated the need for spring-loaded runners, pressure bands, and steel tensioning shoes which contact the film 14 disposed thereon. As such, damage to the film

14 caused by repeated contact with the film trap and gate assembly 24 is reduced or eliminated resulting in a decrease in film damage.

[0059] In closing, it is noted that specific illustrative embodiments of the invention have been disclosed hereinabove. However, it is to be understood that the invention is not limited to these specific embodiments. Accordingly, the invention is not limited to the precise embodiments described in detail hereinabove. With respect to the claims, it is applicant's intention that the claims not be interpreted in accordance with the sixth paragraph of 35 U.S.C. § 112 unless the term "means" is used followed by a functional statement. Further, with respect to the claims, it should be understood that any of the claims described below may be combined for the purposes of the invention.